

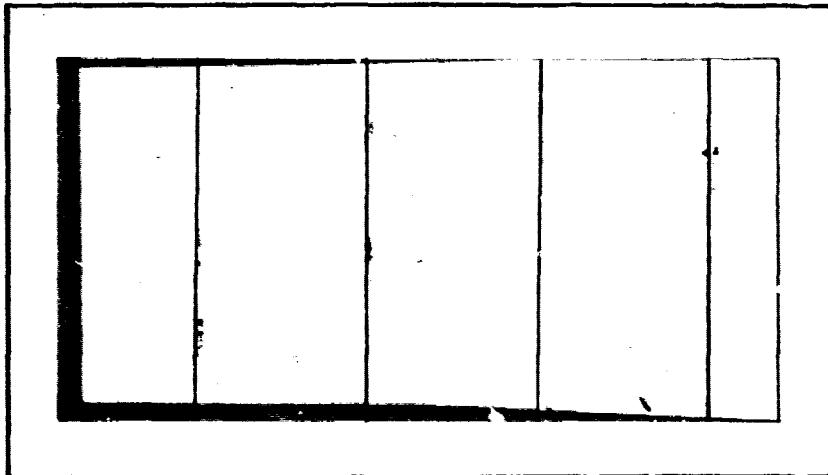
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TECHNOLOGY UTILIZATION DEVELOPMENT PROGRAM  
Final Report, 1 Jun. 1974 - 10 Oct. 1975

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NASA CR-

144545

**FINAL REPORT**

**INTEGRATED LIFE SCIENCES  
TECHNOLOGY UTILIZATION  
DEVELOPMENT PROGRAM**

**OCTOBER, 1975**

**Prepared by:**

**MARTIN MARIETTA CORPORATION**

## **FOREWORD**

This report summarizes the work performed on Contract NAS9-14215 from June 1, 1974 through October 10, 1975 and is submitted in accordance with the requirements of General Provision Clause 64, Article XVI, Reports of Work and Documentation.

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## INTRODUCTION

This report addresses activities performed by the Martin Marietta Corporation on the Integrated Life Sciences Technology Utilization (TU) Development Program between July 1, 1974 and October 10, 1975. Approximately 85% of the work was performed by MMC engineers located in Houston and the balance by Denver personnel. A percentage breakdown of time expended for the major program functions is included in this report.

The major goal of the TU program was to maximize the development of operable hardware and systems which will be of substantial benefit to the public. During this period MMC was involved on six such request projects which resulted in the development of five working prototypes and a meal system for the elderly now undergoing field evaluation. MMC has reviewed 35 requests and of these 8 are currently active and 5 on "Hot" status.

This report details the disposition of all requests received and defines the status of ongoing projects. Manpower utilization is shown relative to the volume of requests in work for each month from July, 1974 through September, 1975. Observations and recommendations, compiled during the contract period, have been listed to further expedite the processing, evaluation and solution development for incoming medically related problem requests.

Other projects assigned, such as the ASTP Mobile Laboratories and Post Skylab Bedrest Study, are discussed, and a trip summary provides the location and purpose of all program travel.

## 1.0 TECHNOLOGY UTILIZATION

### 1.1 Recommendation Summary

The following recommendations are based on MMC's experience and observations during the past 15 month biomedical applications performance period. Most of these items have been extracted and summarized from the foregoing description in Section 1.2 of this report. They are offered as a means to expedite technological transfer and increase the number of operable products available for public benefit.

- Direct solicitation activity towards specific applications for which JSC-LSD is most technically qualified and which are within the scope of manpower and budgetary resources; we recommend that initially not more than 6 such application categories be identified and pursued.
- Control the solicitation activity such that a manageable backlog of requests are received and sufficient emphasis can be placed on problem analysis, solution planning and development.
- For requests of merit keep the requester regularly informed through all project phases.
- Document all pertinent information and maintain a single ordered and complete file for each request project.
- Assign a single TU member the responsibility for: maintaining, reporting and distributing status information, maintaining request data file integrity and coordinating action item accomplishments.

- Monitor and record completed hardware/system operational status and provide such information to originators submitting requests requiring a similar solution.
- Review and identify information sources which provide greater return of relevant data consistent with reporting time requirements. Associate these sources with the specific application subject, document and include in progress report.
- Reserve the DE level TU Review Board judgements and attention for:
  - a) overall program conduct and progress,
  - b) additional NASA-JSC or contractor participation to support project design, development or test functions,
  - c) other additional resources, or involvement by other agencies or institutions,
  - d) activities related to the planning and development of request solutions.
- Review paper requirements for redundancy and consolidate where possible. The stand alone requirement for documents generated for a given request project (i.e., background report, feasibility study, implementation plan) necessitates substantial duplication of information such as background, objective, problem statement.
- Develop and maintain a contact listing of key personnel assigned to the other biomedical applications teams. Exchange project information with these individuals to supplement request background evaluation and initial request merit review.

- For requests of merit, develop a preliminary schedule for the accomplishment of project milestones with LS TU and necessary consultant manpower estimates and include in the Background Report. This information may then be used in determining request project priorities.
- Identify application projects now assigned to other DE or DA personnel, determine LS TU team involvement. If applicable, scope the support requirement with manpower estimate of these projects along with existing backlogged requests and requests on HOLD status and factor into overall priority listing and program goals for the next 12 months.
- Develop solicitation plan after priorities and time estimates for existing projects has been completed.
- Develop basic criteria for the selection and acceptance of new requests including skill, manpower and other resource availability.

## 1.2 Lessons Learned and Recommendation Discussion

### A. Documentation and Request Disposition

After initial request screening the system for determining request disposition is usually contingent on the observations, recommendations and conclusions expressed in documentation submitted by the applications team. During the current performance period these documents included position papers or surveys, feasibility studies and implementation plans. During the follow-on effort the background report will be added as a means to judge a request's qualifications assuming it has been initially accepted as meritorious.

Several methods have been employed to expedite document submittal, review, discussion and decision regarding future request activity. During this period all TU documentation authored by MMC was distributed to the Technical Monitor, branch (DE5) and division (DE) personnel. Implementation Plans (final), Statements of Work, Memos of Agreement, Test Plans (final), Specs. and User Manuals required DE approval signatures. This process on occasion proved burdensome and instructional routing sheets were employed to better inform document recipients of their required action. Evaluatory forms with due dates were later added to the routing sheets to expedite document review and comment feedback. In November, 1974 the Technical Monitor, G. Primeaux, modified the document transmittal procedure by distributing recently published materials at the DE PRB meetings, requesting comments by a specified date. These meetings were discontinued in March, 1975.

A new procedure is needed to avoid a backlogging of requests at various states of progression and to provide better continuity from request evaluation through solution development. To accomplish this the following actions are recommended:

- 1) Establish a review board consisting of the Technical Monitor (TM), an applications office representative and a branch level office representative to act upon application team recommendations for requests previously judged, with the TM's cognizance, to be worthy of a detailed evaluation. This board should convene bi-weekly when judgements are required and more frequently if the volume of request activity dictates. Members of this board, at the request of the TM, might preside at project status review meetings scheduled to review progress for request activity which has proceeded to the implementation planning and solution development phases.

- 2) Continue bi-weekly general status meetings attended by the applications team and TM. These meetings should serve to inform the Technical Monitor of request progress, identify resolution of previously reported action items and report problem areas not previously communicated.
- 3) Continue preparation of the bi-weekly status report at the status meetings with distribution to the TM, Applications Officer, Branch, Division, and applications file. The status report should summarize problems, actions and record submittals.
- 4) Direct judgements of the request initial merit to the applications team with concurrence by the TM.
- 5) Reserve division (DE) level involvement for the following kinds of request activity:
  - (a) wherein multi or joint institutional/agency involvement is recommended or anticipated to study, define, design, develop or test the solution(s),
  - (b) wherein other NASA or JSC organizations not currently affiliated with the TU program are recommended or required to support request solution activities,
  - (c) wherein resources outside NASA or JSC are recommended to support some facet of the request solution activities,
  - (d) when the Technical Monitor and/or Branch personnel determine that DE involvement is necessary.
  - (e) to review and approve Implementation Plans.

- 6) The applications data monitor should submit all documents for technical review to DE personnel designated by the TM. A cover letter with a suspense date two weeks from report submittal should be affixed to each document. Ten days after distribution the data monitor should contact the report recipients for comments and collect those available. Comments should be directed to the author and discussed with the TM where necessary.
- 7) Delete the Evaluation Form from document submittals. Comments may be written in the report and transmitted to the applications team data monitor (R. Michaud).

Table 1.2-1 identifies the key documentation for which request disposition is determined and the NASA participants recommended for review and concurrence at each decision level.

#### B. Project Status and Data Control

During this performance period a working file was maintained for each active project by MMC in Bldg. 36. Master copies of all request documentation produced by MMC were placed in the DE TU file. Request background material where it existed was maintained in the DE6 TU files.

With the exception of report masters and NASA sensitive materials all request related information, background data, status, contacts, reports, etc. should be centralized and maintained in a single ordered file. Technical reports produced by implementing or consortium organizations and which are transmitted directly to NASA DE should be provided to the BAT for review and inclusion in the working file.

<u>RECOMMENDATION</u>	<u>SUBMITAL</u>	<u>REVIEW &amp; CONCURRENCE</u>	<u>REMARKS</u>
Drop	Position Paper	TM	Initial input may be oral followed by a memo expressing reason for action.
Proceed or Drop	Background Report	Review Board	
Proceed	Background Report	DE Review	If items 5 a through d, page 5 are anticipated or recommended.
Proceed or Drop	Feasibility Study	Review Board	
Proceed	Feasibility Study	DE Review	If items 5 a through d, page 5 are anticipated or recommended.
N/A	Preliminary Implementation Plan	DE Review & Approval	
N/A	Implementation Plan	DE Review & Approval	

The request data file is established upon receipt of a request and is structured to grow as, and if the project develops. A subfile is created for each major informational segment related to the request and the sequence of these subfiles should be identified for all requests to facilitate access.

A request project register or checklist should be located at the front of each request data file. The register will

- identify the data items included in the request data file and will identify the functions completed and the projected date for functions to be performed. Project status information may then be transcribed directly from the project register to the request status forms.

#### C. Background Data File

Some of the problems encountered during the current performance period were perhaps unique because of the utilization of two organizations, MMC and SwRI, for applications activity. However the following items should be considered during background reporting to: (1) assure a complete reference file for historical usage, (2) for project continuity in the event of BAT personnel assignment change, or (3) to avoid repetitious contacts when request research activity is intermittent.

A distinction is made between Background Data File and Background Report. The report is the submitted document containing the pertinent background information extracted from the Background Data File. The report is considered a part of the Background Data File and should contain conclusions and recommendations which do not necessarily reside elsewhere in the data file.

Based on our experience during this period, we offer the following recommendations and observations:

- All correspondence to and from the requester and other data sources should be included in the background data file.
- All telephone conversations during which pertinent information is obtained regarding a request, its solution or relevant considerations should be documented along with the name, number, title and/or function of the individual, organizational affiliation and date; this information may later be summarily tabulated for use in the Background Report.
- Related development work, past or present, should be documented with as much specific information, i.e. - developer/user, dates, costs, designs, conclusions, as can be gleened. If this information pertains to the BAT recommendation for request continuance or termination then it should be included and referenced in the Background Report.
- Background literature should be titled and included in the data file. Such information which is pertinent and bears directly on the BAT recommendations for action should be incorporated in the report. Background literature not yet received should be referenced by subject matter, repository, data bank or source, and anticipated date of receipt.
- For information received, which pertains to other requests in work, it should be copied or documented and provided to the responsible individual(s) assigned the request(s).
- For Background Reports in which action to proceed is recommended, contact work yet to be performed should be indicated when supplementary information is anticipated. Name, function, organizational affiliation and a brief description of subject material expected or reason for the contact should be included.

#### D. Solution Implementation

Where possible, and particularly for request solutions involving operable hardware, the same organization should be utilized throughout the implementation phase including system design, development, test, documentation preparation and reporting, and field evaluation support. This approach will expedite system development, reduce the coordination required between implementation phases and should reduce cost. The BAT interface with the implementor should, where possible, be single point. BAT participation is mandatory at all reviews and status meetings to preserve continuity, unless the BAT is to be absolved from the implementation monitoring and coordination activities.

Consortium members should be encouraged to conduct in-house reviews prior to formal NASA/BAT attended review to assure preparedness and compliance with requirements. Data packages supporting the solution design, test, evaluation, et.al. should be complete and available for NASA/BAT reference. Data requirements should be described in the SOW including scope, level of detail, format and copies required.

#### 1.3 Request Activity

A. Since June, 1974 MMC has participated with the disposition of 35 requests. Our role has varied - from informal review, to solicitation, detailed evaluation, study and planning to prototype development and coordination. A number of requests had been received prior to MMC's assignment to the applications program and some had received intermittent attention including preliminary surveys and periodic communication with the requester.

Table 1.3-1 identifies each of the requests, and where known, dates originally received and when PRB action occurred and date received by MMC. General disposition of each request is also shown.

TABLE 1.3-1 REQUESTS INVOLVING MMC PARTICIPATION

REQUEST	ORIG. REQUEST DATE	PROB. ACTION DATE	DATE REC'D BY MMC	DISPOSITION
AEB-5 Rocking Motion Sensor	7-73	6-10-74		Ongoing-Prototype developed & delivered AEB for evaluation
CHS-10 Hearing Aid Malfunction Detection Unit	7-73	6-18-74		Ongoing-2 prototypes developed for delivery to JSC in Oct. 75.
SWR-116 Packaged Food for the Elderly	3-28-74	6-10-74		Ongoing-food and packaging field test initiated in Oct. 75.
JSC-101 Mobile Biological Isolation System	1-11-74	1-15-74	6-74	Ongoing-awaiting agreement signoff by Baylor
JSC-123 Oxygen Cocoon for Burn Victims	4-4-74		7-12-74	Ongoing-Evaluation unit chamber testing is pending.
IOU-1 Sputum Viscometer		6-25-74	7-29-74	Surveyed & Dropped
SWR-112 Instrumentation for the Blind	2-15-74	6-11-74	8-2-74	Surveyed-Talking voltmeter demonstrated to S.E. Okla Univ.; closed 6-75
CRH-1 Differentially Inflated Seat Cushion		6-25-74	7-30-74	Surveyed & Dropped
JSC-111 Catheter for Cerebrovascular Surgical Brain Repair	2-24-74	8-13-74	8-20-74	Surveyed & Dropped
TCB-20. Blind Diabetic Urinalysis Device		6-25-74	8-20-74	Surveyed & Dropped
SMR-117 Auto Analysis of Drugs in Body Fluids			8-20-74	No Action, Request Dropped
JSC-124 Ultrasonic Identification of Nerve Damage			8-20-74	No Action, Request Dropped

TABLE 1.3-1 REQUESTS INVOLVING MMC PARTICIPATION (CONT.)

<u>REQUEST</u>	<u>ORIG. REQUEST DATE</u>	<u>PROB. ACTION DATE</u>	<u>DATE REC'D BY MMC</u>	<u>DISPOSITION</u>
UTM-39 <b>Multi-Channel Hypothermia Blanket for Heart Surgery</b>		6-25-74	8-20-74	Surveyed and Dropped
CRH-7 <b>Lunar Rover Control for the Handicapped</b>	3-23-73			Ongoing - VA contract let for Phase 2
JSC-C155 <b>Air Free Blood Syringe</b>	9-24-74		11-6-74	Surveyed & Dropped 2-25-75
Inhouse <b>Telecare</b>	9-16-74	9-17-74	10-7-74	Ongoing at Directorate level
Proposal 1 <b>Telemetry Subcarrier Adapter</b>		11-6-74		Surveyed & Dropped 2-25-75
Proposal 1 <b>Implantable Sensor for Coronary Bypass</b>		11-15-74		On Hold - Plan & Cost Estimate Submitted
Proposal 1 <b>Blood Cell Counter</b>		11-25-74		Surveyed & Dropped 2-25-75
Inhouse <b>Anti-Hypertensive Garment</b>		11-25-74		Surveyed & Dropped 2-25-75
SWR-143 <b>Cooling Probe for Neuro Studies</b>		12-2-74		Surveyed & Dropped 2-25-75
Proposal 1 <b>Cardiotachometer</b>		12-20-74		Reviewed & Dropped
Proposal 1 <b>Personal Hygiene Washing System</b>		1-10-75		Surveyed & Dropped 2-25-75
Proposal 1 <b>Arterial Pulse Monitor</b>		12-20-74		On Hold pending Preliminary Plan Development and Review by JSC & Justice Dept.
Proposal 1 <b>Hospital Feeding &amp; Dietary Control System</b>		2-17-75		Position Report Written, Project on Hold.
Inhouse <b>Emergency Medical System Survey</b>		4-1-75		Ongoing - Problem Analysis Completed

TABLE 1.3-1 REQUESTS INVOLVING MMC PARTICIPATION (CONT.)

<u>REQUEST</u>	<u>ORIG. REQUEST DATE</u>	<u>PROB. ACTION DATE</u>	<u>DATE REC'D BY MMC</u>	<u>DISPOSITION</u>
JSC-211      Respiratory Ventilator Malfunction Alarm		4-29-75		Prototype developed & demonstrated
Inhouse      TCH analysis of Isolator Unit and Food Sterilization		8-13-75		On Hold pending DA/Baylor resolution on MBIS
SWR-178      Environmental Control System for Bedridden Patients with Abnormal Thermoregulation		~10-14-74		Reviewed for PRB on 10-22-74; Current Status unknown.
SWR- 134      Non-Invasive Measurement of Cardiac Output and Pulmonary Parenchymal Tissue Volume		~10-14-74		Reviewed for PRB on 10-22-74; Current Status unknown.
SWR-139      Methods & Sensors for Continuous Areas of pH, pO <sub>2</sub> & pCO <sub>2</sub>		~10-14-74		Reviewed for PRB on 10-22-74; Current Status unknown.
SWR-137      Instrumentation for the Assessment of Surgical Repair to Correct Incontinence		~10-14-74		Reviewed for PRB on 10-22-74; Current Status unknown.
SWR-135      Body Pressure Measurement		~10-14-74		Reviewed for PRB on 10-22-74; Current Status unknown.
-----      Implantable Prosthetic Device		~10-14-74		Reviewed for PRB on 10-22-74; Current Status unknown.
JSC-127      Heat/Cooling System for Oil Field Workers	4-8-74	8-13-74	11-6-74	Request withdrawn

In Table 1.3-2 the request projects are categorized - whether received through the system, (incoming requests with an identifier assigned), inhouse or proposed.

Within each of the three categories, the number of requests which are "Active", or "Hold" or "Dropped" is included. Additional groupings are provided for "Incoming Requests".

#### B. Documentation

Documentation was prepared for 21 of the requests assigned to MMC. Table 1.3-3 specifies the number of request projects for which the various reports were produced. "Other" includes memos, critiques and inputs to the Headquarters TU Quarterly Progress Report. Implementation Plans were developed for 7 projects including the General Plan for the "Implantable Sensor for Coronary Bypass" project. Inputs for the annual Congressional Report were recently completed in September. Of the 13 projects described, MMC had previously been involved with 6.

The dates on which project documentation was submitted are shown on Table 1.3-4. Preliminary, final and revised editions are indicated by a letter code. Documents and paper submittals not assigned as column headers are identified in the last column marked "OTHER".

#### C. System/Hardware Development

MMC participated in 6 request projects on which development status has been achieved. These projects and their development status are identified in Table 1.3-5.

**TABLE 1.3-2 REQUEST PROJECT CATEGORIES**

<b>Incoming Requests</b>	<b>24 (with request no.)</b>
Solicited by MMC	1
SWR Req. #	10
JSC Req.	7
Other Req.	7
Active	7
Dropped	17
 Inhouse Projects	 4
Active (DE)	1
Dropped	1
Hold	2
 Proposed Request Projects	 7
Active	1
Hold	2
Dropped	4
 <b>TOTAL</b>	 <b>35</b> involving MMC participation

TABLE 1.3-3

SUMMARY - TYPES OF REPORTS/DOCUMENTS

<b>Position Reports</b>	<b>3</b>
<b>Surveys</b>	<b>11</b>
<b>Feasibility Studies</b>	<b>3</b>
<b>Implementation Plans</b>	<b>7</b>
<b>SOW's</b>	<b>4</b>
<b>Test Plans</b>	<b>3</b>
<b>New Technology Reports</b>	<b>3</b>
<b>Other</b>	<b>6</b>
<b>Reviewed-Oral Report</b>	<b>12</b>
<b>Annual Congressional Report Draft</b>	<b>13</b>

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TABLE 1.3-4 REQUEST PROJECT DOCUMENTATION SUMMARY

REQUEST	POSITION REPORT	POSITION SURVEY	FEASIB. REPORT	IMPLEMENT PLAN	SOW	TEST PLAN	EVAL PLAN	NEW TECH	OTHER
AEB-5 Rocking Motion Sensor	8-30-74		P 10-11-74 F 12-5-74	8-16-74				12-4-74	Memo of agreement; Detailed prototype design
CHS-10 Hearing Aid Malfunction Detection Unit	8-30-74		12-20-74	2-75	9-5-75			6-2-75	Quarterly Progress Report Inputs; Prototype Data Pg. Submitted 10-6-75
SMR-116 Packaged Food for Elderly	7-5-74	7-23-74	P 9-3-74 F 3-10-75			5-9-75			
JSC-101 Mobile Biological Isolation System			8-16-74				11-11-74		Preliminary Test Requirements 9-6-74
JSC-123 Oxygen Cocoon for Burn Victims			7-30-74	P 10-28-74 F 11-27-74 R 2-7-75 R 4-23-75	12-6-74				Quarterly Progress Report Input
100-1 Sputum Viscometer			8-5-74						
SMR-112 Instrumentation for the Blind				10-28-74					
CRH-1 Differentially Inflated Seat Cushion				8-30-74					
JSC-111 Catheters for Cerebrovascular Surgical Brain Repair				10-15-74					
UM-39 Multi-Channel Hypo-Thermal Blanket for Heart Surgery				5-16-75					
CRH-7 Lunar Rover Control for the Handicapped									SRRI Study Report Critique 8-16-75
JSC-C155 Air Free Blood Syringe					11-20-74				

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TABLE 1.3-4 REQUEST PROJECT DOCUMENTATION SUMMARY (CONT.)

REQUEST	POSITION REPORT	SURVEY	FEASIB. REPORT	IMPLEMENT PLAN	SOW	TEST PLAN	EVAL. PLAN	NEW TECH	OTHER
Inhouse Telecare			P 10-25-74 F 11-5-74		12-10-74				
Proposal Telemetry Subcarrier Adapter		11-29-74 R 12-20-74							
Proposal Implantable Sensor for Coronary Bypass				12-26-74					
Inhouse Blood Cell Counter			12-2-74						
Proposal Personal Hygiene Washing System			1-31-75			5-19-75			
Proposal Arterial Pulse Monitor			1-28-75						
Proposal Hospital Feeding & Dietary Control System			3-21-75						
Inhouse Emergency Medical System Survey			10-1-75						
JSC-211 Respiratory Ventilator Mal-function Alarm								9-22-75	

TABLE 1.3-5 SYSTEM/HARDWARE DEVELOPMENT STATUS

ASSIGNED PROJECT	DEVELOPMENT STATUS
SWR-116      Packaged Food for the Elderly	Phase II meal packages developed and distributed Oct. 75 to field evaluation sites.
AEB-5      Rocking Motion Sensor	2 prototypes and 1 sensor delivered to AEB, Apr. 75 for on-subject evaluation; evaluation still in progress.
CHS-10      Hearing Aid Malfunction Detection Unit	2 prototypes to be delivered to JSC in Oct. 75 for subsequent evaluation at Calliers in Dallas.
JSC-123      Oxygen Cocoon for Burn Victims	Prototype unit completed in May, 1975; JSC chamber evaluation pending schedule availability.
JSC-101      Mobile Biological Isolation System	Testing completed on deliverable ventilator, transporter and prototype suit; subject suit fabrication, test and system delivery pending Baylor acceptance.
JSC-211      Respiratory Ventilator Malfunction Alarm	Pressure sensor prototype developed; testing to be performed.

## 1.4 Manpower Expenditure

MMC's total manpower expenditure for TU activities through 10-3-75 are plotted against number of requests in work in Figure 1.4-1. The portion of MMC TU manpower used for solution design and development is also shown by the bottom (shaded) curve. This manpower was devoted mainly to the AEB-5 Rocking Motion Sensor (CY 1974) and to the CHS-10 Hearing Aid Malfunction Detection Unit (CY 1975). Coordination of these design and development functions by the Houston base applications team is not included in the shaded manpower profile.

Table 1.4-2 reflects the monthly net change of requests in work. The resulting totals were plotted in the upper curve on the preceding figure (1.4-1). The monthly totals include request projects on "Hold" status such as JSC-101 MBIS, Hospital Feeding and Dietary Control System, Implantable Sensor for Coronary Bypass, and Telecare.

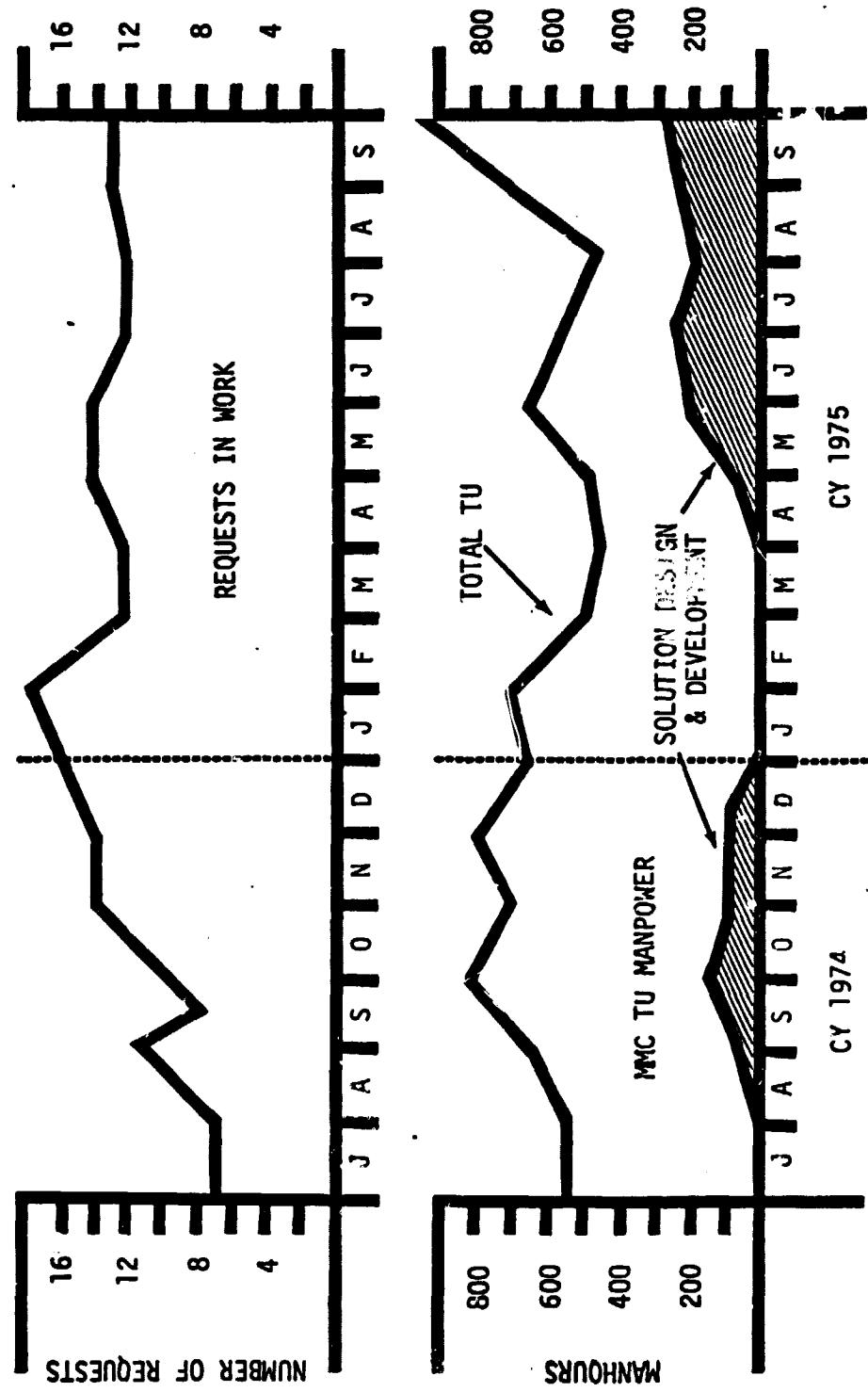


FIGURE 1.4-1 MANPOWER EXPENDITURE/REQUESTS IN WORK

TABLE 1.4-2

## REQUEST WORKLOAD BY MONTH.

<u>MONTH</u>	<u>ADDED</u>	<u>DROPPED</u>	<u>TOTAL</u>
July	7	-	7
August	5	1	11
September	1	4	8
October	7	1	14
November	6	6	14
December	3	1	16
January	2	1	17
February	1	6	12
March	-	-	12
April	2	-	14
May	-	-	14
June	-	2	12
July	-	-	12
August	1	-	13
September	-	-	13

## 2.0 MOBILE LABS

MMC's support to the refurbishment and operation of the Mobile Labs for ASTP recovery was provided by R. Kessinger as Team Supervisor and R. Michaud as Logistics Engineer. Work was performed from January through August 1975.

A detailed plan for the activation and support of the Mobile Labs for ASTP was prepared and reviewed with the Technical Monitor, Gary Primeaux, in January, 1975. This plan included recommendations for the Mobile Lab organization of NASA, MMC and NSI personnel, functional assignments and responsibilities, preliminary milestone schedules and MMC manloading requirements. Equipment procurement, lab refurbishment, maintenance, and experiment modifications were initiated in the January/February period. A detailed work schedule was presented in March with operational readiness by May 1 as the major goal.

During April lab modification to the ASTP configuration was completed. Calibration and verification of lab equipment and installation of systems to support the new experiment hardware for the Isometric Chair and Pulmonary Function was performed. The Data Acquisition System and Skylab experiment hardware were tested, calibrated and verified and an end-to-end functional verification with test subject was accomplished. Fifty (50) percent of the lab stowage was completed in April.

Operational readiness was attained May 1. First full-up systems test using ASTP protocol were conducted and all medical data generated from Skylab experiments in Data Acquisition System (DAS) was transmitted through the system for verification. The capital equipment was inventoried in early June and baseline medical data was acquired for both the prime and backup crews during the L-30 and L-15 day physical examinations.

Lab preparation for deployment by C-5A and carrier was accomplished on June 30. The Mobile Labs were transported from Ellington AFB to San Diego's North Island NAS by C-5A aircraft on July 1. Perishable

blood and microbiology supplies were transferred and stored in the recovery ships' (USS New Orleans) refrigerators. Power transfer was performed following lab transfer to the ship. Equipment preparation, systems verification and operation simulations were performed en route to Pearl Harbor.

MMC support continued through crew recovery although the inhalation problem curtailed post flight medical examinations. The support team and labs returned to Ellington AFB on July 27. In August, MMC developed a plan for the dismantling and deactivation of the labs and equipment. This plan was implemented by NSI (contractor) personnel.

### 3.0 BEDREST

Bedrest studies designed to determine whether extended bedrest produces physiological effects similar to those observed in returned Apollo and Skylab crewmen were initiated in January, 1975. Locating, assembling Skylab experiment hardware, and support of experiment hardware/data systems was assigned to Joe Morgan during February. Support from Northrup Services Inc. was attained to build interconnecting electrical harnesses, to assist in transfer of equipment from JSC to the Houston hospital district and to support testing, maintenance, and operation of the bedrest equipment.

Despite equipment difficulties the bedrest program pre-test started as scheduled on April 23, 1975 at the Medical Towers building near the Baylor College of Medicine.

The first phase was completed in August, 1975, and the second is scheduled for the beginning of next year. The six subjects of the first phase were normal healthy paid volunteers whose mean age was 30. Their occupations varied from railroad worker to university professor, but all were intelligent, highly motivated individuals who were interested in the goals of the project and cooperated with the investigators to the fullest in achieving these goals. Subject motivation is particularly important because in several of the medical experiments attitude and motivation can play a large role, particularly in the subjects's desire to regain his normal physical state postbedrest. The subjects were allowed relatively normal activity during the control period pre-and postbedrest and visitors, TV, books and magazines during bedrest which enhanced their motivation and kept them alert, a situation more nearly approximating the busy challenging environment of the astronauts than an isolation study. The psychiatrist detected no significant change in mental state or untoward stress during the entire seven weeks.

During the entire test period three weeks pre-, two weeks bedrest and two weeks postbedrest, the subjects ate the special Skylab

diet in which calories, nutrients and electrolytes were controlled. Subjects were required to eat all that was given them and were allowed to supplement their diets with certain so-called free items; primarily high carbohydrate food stuffs that would add calories to the diet without affecting the electrolyte balances. An attempt was made during a preliminary test diet to individualize the diets taking into consideration food preferences and different caloric needs. Subjects drank deionized water and their water intake was recorded. All urine and excrement were collected for analysis. The testing program pre-and postbedrest was similar to that of Skylab, including most of the same tests: lower body negative pressure for the orthostatic intolerance noted after many flights and bedrest and the bicycle ergometry for the diminished postflight, postbedrest exercise capacity, postural equilibrium and vestibular studies as a followup to the hyperreflexia seen postflight and increased tolerance to motion sickness seen in-flight. Fluid and electrolyte shifts were documented with isotope studies and urine analysis. Red cell mass, plasma volume, total body water, extracellular fluid, total body exchangeable K and the urinary excretion of potassium, sodium, nitrogen, calcium, ADH and aldosterone comprised part of the studies. In addition the subjects were followed by a psychiatrist who watched for signs of stress in the test environment.

Although the data has not been completely analyzed, preliminary observations indicate results which are consistent with the findings of Skylab. Orthostatic intolerance was measured by the LBNP and was present but varied in magnitude among the subjects as did the degree of decreased work capacity. Plasma volume was decreased postbedrest and the initial weight losses and diuresis of bedrest were associated with decreased urinary ADH. Red cell mass decreases were also found with normal survival times. Postbedrest physiological changes of an expected kind and varying degree were found in all but one subject. The reason for his unsusceptibility to the effects of bedrest is unknown. Although the subjects were not restrained during bedrest, they were watched with TV monitors and their activity while in bed was registered by means of a spring loaded potentiometer attached to the bed springs

whose output was fed into a strip chart recorder. It can therefore be documented that the individual who showed the least change did not get out of bed and indeed was not even the most active. From preliminary data the most active individual while at bedrest appears to have demonstrated some of the most dramatic effects postbedrest. In the correlation of these data, it is hoped that useful information will be gained about the mechanism of the changes noted and about what makes an individual particularly susceptible or unsusceptible to the catabolic effects of bedrest. Such information could be extremely useful in the prediction of the effects of weightlessness on the individuals of future shuttle flights who will probably be less highly conditioned than the astronauts.

It is recommended that the phase two bedrest studies be conducted in a facility which would allow those in charge of the test move control of such things as air conditioning, electrical power, and other facility items - an area similar to the building 36 Bio-engineering Laboratory would be ideal.

#### **4.0 PROGRAM MANPOWER UTILIZATION**

In addition to the TU activities, MMC's attention has been directed toward other projects such as the Mobile Laboratory for ASTP and the Bedrest Study. Table 4.0-1 identifies the monthly manpower percentage applied toward each of the major tasks. Technology Utilization is subdivided into three sub-tasks - "Request Analyses and Planning", "Request Solution Design and Development" and "Program Administration, Coordination and Evaluation". Numbers shown for these 3 subtasks reflect their percentage of the total TU budget.

The unofficial total program manhour expenditure by month is indicated across the top of the table. Other non TU assignments include SMS-II, STARPAHC and other tasks which MMC has performed.

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TABLE 4.0-1 PROGRAM TOTAL MANPOWER UTILIZATION

ACTIVITY	CY 1974						CY 1975						TOTAL						
	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT				
TOTAL MANHOURS (MH) EXPENDED	M.H.	571	671	888	771	836	704	362	799	781	802	1047	1288	1218	926	1249	13,474		
TECHNOLOGY UTILIZATION (TU) PERCENT	%															(100%)			
REQUEST ANALYSES & PLANNING	%	94.7	97.5	95.2	90.1	94.6	94.5	79.4	59.3	54.4	55.6	60.7	44.8	39.1	72.8	33.3	71.8%		
REQUEST SOLUTION DESIGN & DEVELOPMENT	%	93.3	83.5	78.3	60.1	75.2	95.4	50.4	39.9	33.8	71.5	50.8	41.2	43.9	41.4	38.3	66.4%		
PROGRAM ADMINISTRATION, COORDINATION & EVALUATION	%	11.5	17.9	16.7	13.3	4.7					17.9	36.5	45.8	43.3	38.4	28.3	18.9%		
MOBILE LABORATORY PERCENT	%	6.7	4.6	3.8	23.2	11.5	9.5	19.6	10.1	16.2	10.6	12.7	13.0	12.8	20.2	33.4	14.7%		
BEDREST STUDY PERCENT	%																15.7%		
OTHER NON TU ASSIGNMENTS PERCENT	%											5.4	18.9	19.7	14.9	17.9	13.8	3.0	6.9%
	%	5.3	2.5	2.4	6.1	4.4	4.4	3.7	7.4	4.4	2.5	2.3	2.5	3.3	12.5	16.8	5.6%		

## **5.0 TRIP SUMMARY**

**Fifteen (15) trips were made by MMC personnel from 9-16-74 through 10-10-75. R. Kessinger and R. Michaud traveled together from 7-1 to 7-27-75 in support of the ASTP Mobile Laboratory recovery operation. Eight (8) of the fifteen (15) trips were taken within Texas in support of SWR-116, the Packaged Food for the Elderly Program.**

**Table 5.0-1 identifies the MMC personnel, dates, location, project and purpose for each trip.**

TABLE 5.0-1

## TRIP SUMMARY

<u>Name</u>	<u>Date</u>	<u>Location</u>	<u>Project</u>	<u>Purpose</u>
J. Morgan	9/16 to 9/18	Little Rock	AEB-5	Review Arkansas Enterprises for Blind (AEB) design requirements for Rocking Motion Sensor
R. Ritz	9/26 & 9/27	Austin	SWR-116	Presentation & Skylab Meal for United Action for Elderly (UAE)
W. Carmean	10/22 to 10/25	Denver	---	Program Coordination and Planning
R. Ritz	12-6	Dallas	SWR-116	Support Presentation of Research Seminar
J. Morgan	1/28 to 1/30	San Antonio	CRH-7	Discuss Lunar Rover Controller for Handicapped Requirement Modifications with SWRI
R. Ritz	2/11 & 2/12	Austin	SWR-116	Coordinate Meal System Planning with Program Associates
R. Kessinger	3/17 to 3/19	Dallas/Denver	CHS-10	Coordinate Hearing Aid Malfunction Detector Requirements with requestor (Calliers) and developer (MMC)
R. Ritz	4/27 & 4/28	Austin	SWR-116	Meal System Program Review with Participating Associates
R. Kessinger	6/17 & 6/18	Denver	CHS-10	Hearing Aid Malf. Detector Design Review
R. Ritz	7/23 to 7/25	Austin	SWR-116	Phase I Review Meeting at LBJ School for Public Affairs (LBJ/SPA)
R. Kessinger / R. Michaud	7/1 to 7/27	San Diego/ Pearl Harbor	ASTP Recovery	Operate Mobile Labs for Crew Recovery
R. Ritz	9/3 to 9/5	Austin	SWR-116	Meal System Coordination Meeting with Program Participants
R. Kessinger	9/22 to 9/24	Denver	CHS-10	Coordinate and review Hearing Aid Malfunction Detector Development Progress
R. Ritz	9/24 & 9/25	Austin	SWR-116	Meal testing Training Session at LBJ/SPA
R. Ritz	10/8 to 10/10	Austin	SWR-116	Visit Food Delivery Sites and Support Field Photography